VCS-E93050 Experimental Offsets Determination for DA1 and DA2 datasets ADDENDUM

H. Fonvieille

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This note is an addendum to my previous memo on offsets (of dec.2001). It reports how the study was conducted further, and contains improved offsets for DA1 and DA2 analysis.

1 Why go further in offset determination

The offsets determined by the previous study and summarized in tables 4 and 6 of my memo of dec.2001, show some systematic correlations [1] which are unwanted. If we consider the setting number, indicated in figure 1 in the usual $(P_p \ vs \ \theta_{HRSH})$ plot, we find correlations of beam energy offset dE0 with this setting number. See figure 2, left plots, dashed lines: a correlation is suggested between dE0 and the hadron arm angle (via the setting number). Other correlations are seen, e.g. E-arm horizontal angular offset dPhiE (in the unconstrained fits) versus setting number, etc. So we pushed the offsets study further with the aim of understanding and eliminating these correlations.

A first idea was to think of a dependency of the E-arm nominal spectrometer angle (which is normally fixed) on the H-arm nominal angle, that had not been already accounted for. But this is hard to believe.

A second idea is that the observed correlations can be due to biases in the E-arm optic database. It is true that, to some level, all databases contain residual biases. However I have not been able to find any clear correlation between offsets (e.g. dPhiE) and regions of phase space filled by each setting (phase space of target or focal plane variables), that could easily be corrected for.

[1] as first noticed by P.Bertin.

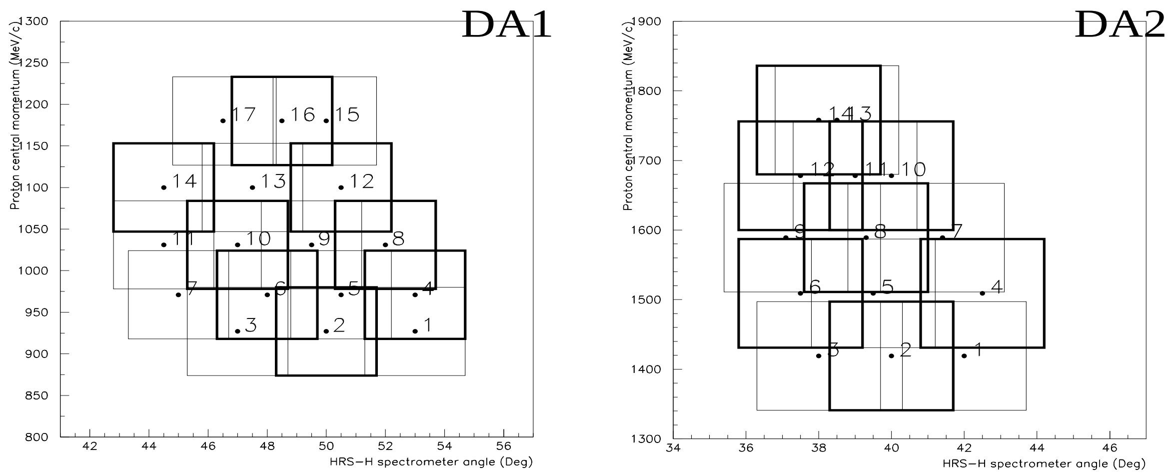


Figure 1: setting location in the (P_p versus θ_{HRSH}) plot. The boxes represent the hadron spectrometer acceptance.

2 Changes in the new study

The present study can be considered as a "third pass" offsets optimization [2]. The basic line remains the same: 1) try to *fix* the maximum number of offsets to a given value, because fitting just the missing mass does not allow to determine too many offsets. 2) let the beam energy offset dE0 free and see at the end the consistency of the obtained values.

2.1 Absolute momenta and Gamma Factors

In the previous study we had adjusted the offset dPe in E-arm absolute momentum in order to account for the most precise value of the E-arm gamma factor : $\Gamma_E = 270.2$ MeV/kG. But we had not done this in the Hadron arm.

Now we do the same in the H-arm, i.e. we adjust the offset dPp in H-arm absolute momentum in order to account for the most precise gamma factor : $\Gamma_H = 269.9$ MeV/kG instead of 269.4 as we had always taken. For DA1 this induces an offset dPp of about 1.4 to 1.7 MeV/c. For DA2 this induces an offset dPp of about 2.6 to 3.3 MeV/c (depending on the setting number). This is actually the main change w.r.t. the previous study.

2.2 Other changes

I did a fine tuning of the E-arm nominal angle of the DA2 settings. Changes are smaller than $\pm$ 0.1 mr. Also, experimental Ntuples were re-made with the offsets of Dec.2001 (just in case the background cuts would be very sensitive to the offsets). Fitted missing mass parametric functions from simulation were checked.

[2]First pass: was in year 2000. Second pass: results of my previous memo of Dec.2001.

3 DA1 study: new results

Offsets in vertical angles are kept unchanged w.r.t. previous study: dThetaE= -1.6 mr, dThetaH= 0. In an unconstrained fit, the average E-arm horizontal angular offset dPhiE is still found around +0.09 mr, so we fix it to this value. The average H-arm horizontal angular offset dPhiH is still found around -1.70 mr, so we fix it to this value. Then we perform an optimization with the beam energy offset dE0 as the only free parameter. Results are reported in table 1 and figure 2 (solid lines).

file da1-off-12

T	set	dE0	dPe	dPp	dPhiE	dPhiH	dTheE	dTheH
		MeV	...MeV/c..		.....mr.....		.....mr....	
1	8	-09.9	0.00	0.00	+0.09	-1.70	-1.60	0.00
2	9	-10.2	0.00	0.00	+0.09	-1.70	-1.60	0.00
3	11	-09.8	0.00	0.00	+0.09	-1.70	-1.60	0.00
4	10	-09.8	0.00	0.00	+0.09	-1.70	-1.60	0.00
5	14	-10.8	0.00	0.00	+0.09	-1.70	-1.60	0.00
6	13	-11.2	0.00	0.00	+0.09	-1.70	-1.60	0.00
7	12	-10.9	0.00	0.00	+0.09	-1.70	-1.60	0.00
8	15	-13.1	0.00	0.00	+0.09	-1.70	-1.60	0.00
9	16	-12.9	0.00	0.00	+0.09	-1.70	-1.60	0.00
10	17	-13.0	0.00	0.00	+0.09	-1.70	-1.60	0.00
11	3	-11.6	0.00	0.00	+0.09	-1.70	-1.60	0.00
12	2	-12.1	0.00	0.00	+0.09	-1.70	-1.60	0.00
13	1	-11.0	0.00	0.00	+0.09	-1.70	-1.60	0.00
14	4	-10.9	0.00	0.00	+0.09	-1.70	-1.60	0.00
15	5	-10.9	0.00	0.00	+0.09	-1.70	-1.60	0.00
16	6	-10.8	0.00	0.00	+0.09	-1.70	-1.60	0.00
17	7	-10.7	0.00	0.00	+0.09	-1.70	-1.60	0.00

Table 1: T is a time index. "set" is the setting number. Offset dE0 in beam energy is relative to the nominal 4045 MeV of the headerfiles. The new offset dPp does not appear in the table but is put upstream in the analysis.

4 DA2 study: new results

Offsets in vertical angles are kept unchanged w.r.t. previous study: dThetaE= -0.54 mr, dThetaH= 0. In an unconstrained fit, the average E-arm horizontal angular offset dPhiE is still found around zero, so we fix dPhiE=0. The average H-arm horizontal angular offset dPhiH is found around -0.70 mr, so we fix it to this value [3]. Then we perform an optimization with the beam energy offset dE0 as the only free parameter. Results are reported in table 2 and figure 2 (solid lines). Sometimes the two missing mass peaks (VCS and π^0) are not both well centered. For settings # 1,4,7 the quoted result is the one obtained by centering the VCS peak alone.

file da2-off-14

T	set	dE0	dPe	dPp	dPhiE	dPhiH	dTheE	dTheH
		MeV	...MeV/c..		.....mr.....		.....mr....	
1	1	-12.3	0.00	0.00	+0.00	-0.70	-0.54	0.00
2	4	-12.4	0.00	0.00	+0.00	-0.70	-0.54	0.00
3	5	-15.3	0.00	0.00	+0.00	-0.70	-0.54	0.00

[3] It is hard to understand why the average dPhiH has changed by 1 mr between DA1 and DA2, given that it's the same H-arm optic database in the two cases. The only explanation I can think of is a hardware change of the optics with the proton central momentum ($\sim$ 1 GeV/c for DA1, $\sim$ 1.6 GeV/c for DA2).

4	6	-14.9	0.00	0.00	+0.00	-0.70	-0.54	0.00
5	2	-13.2	0.00	0.00	+0.00	-0.70	-0.54	0.00
6	3	-15.1	0.00	0.00	+0.00	-0.70	-0.54	0.00
7	14	-15.1	0.00	0.00	+0.00	-0.70	-0.54	0.00
8	13	-15.7	0.00	0.00	+0.00	-0.70	-0.54	0.00
9	10	-13.5	0.00	0.00	+0.00	-0.70	-0.54	0.00
10	11	-14.0	0.00	0.00	+0.00	-0.70	-0.54	0.00
11	12	-15.1	0.00	0.00	+0.00	-0.70	-0.54	0.00
12	9	-14.0	0.00	0.00	+0.00	-0.70	-0.54	0.00
13	8	-13.5	0.00	0.00	+0.00	-0.70	-0.54	0.00
14	7	-11.7	0.00	0.00	+0.00	-0.70	-0.54	0.00

Table 2: same as table 1 but for DA2 datasets.

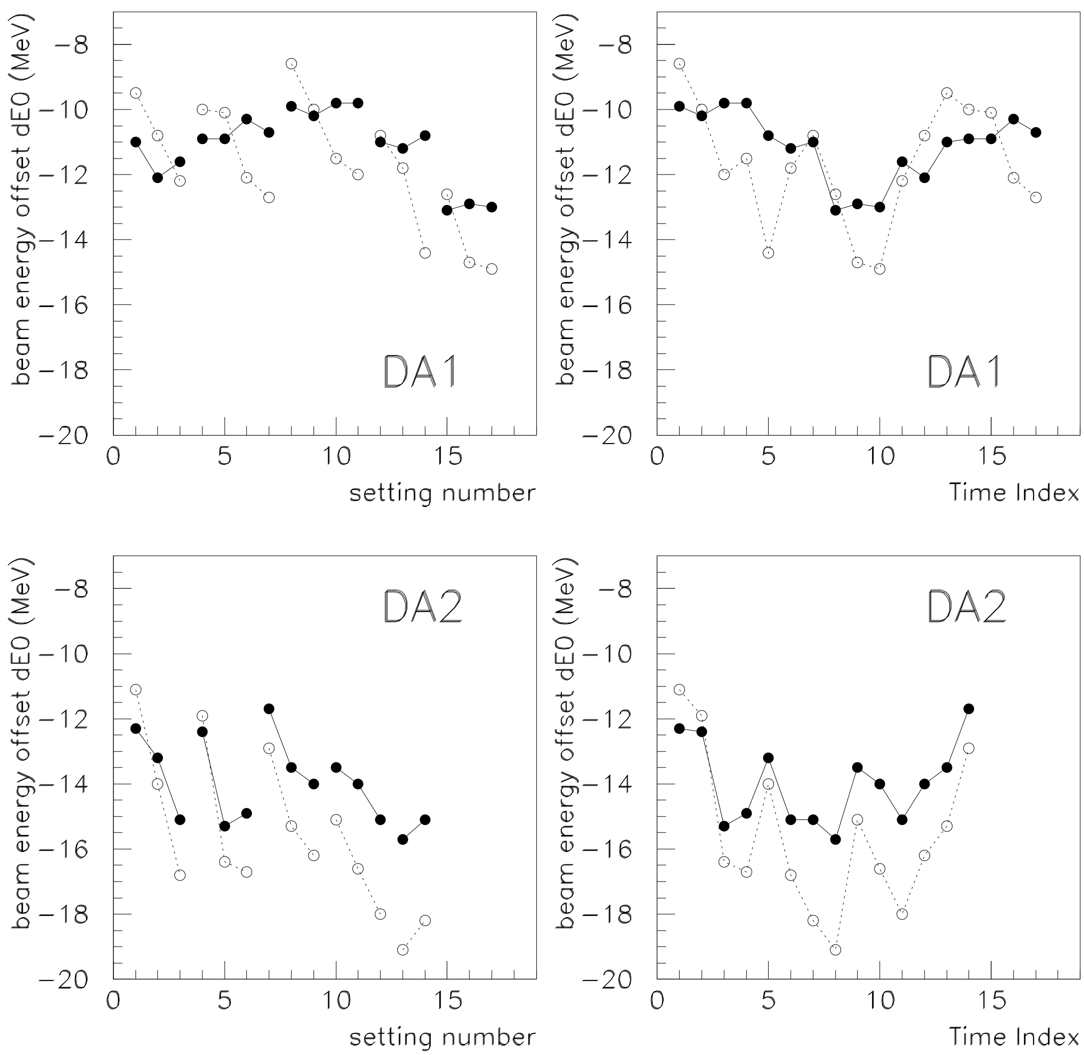


Figure 2: new (solid line) and previous (dashed line) beam energy offset dE0, versus setting number and versus time, for both datasets DA1 and DA2. On the left plots, each line connects the points which are at the same proton central momentum, and hence varying H-arm angles.

5 Conclusions

• Let's summarize the main improvements gained with these new offsets:

1) there is less correlation of the beam energy offset dE0 with "hadron arm angle". See figure 2, left plots. For DA1, this kind of correlation is fully suppressed, however the groups of points (connected by lines) are still spread versus proton central momenta. This may be due to an offset that differs each time we have set a new magnetic field in the hadron dipole. For DA2, the systematic correlation of dE0 versus "H-arm angle" has been reduced, although not completely suppressed.

2) as a consequence, there is now a better stability of beam energy offset versus time. See figure 2, right plots. For DA1, dE0 lies within 3.3 MeV wide with an average of $\sim$ -11 MeV. For DA2, dE0 lies within 4 MeV wide with an average of $\sim$ -14 MeV.

• The only improvement that I really understand comes from having used the most reliable gamma factor Γ_H. Are the present offsets reliable enough ? Once again, fitting the missing mass does not give a unique solution, when several offsets are to be determined. We have to estimate which offset behaviors are reasonable or not. Another completely different approach would be, for example, to fix the beam energy offset to a constant value for all E93050 data; and then see what we get as angular offsets... (but this is another story).

6 Addendum 1

This section contains a series of plots showing the quality of the final centering in missing mass squared, for the present study, setting per setting. For each setting there are two plots: top = the VCS peak region, bottom = the π^0 peak region.
N.B.: around 12000 MeV^2 what appears to be a "peak" is a cut to reduce the number of π^0 events w.r.t. VCS. The fitted region is the one bounded by the most left and right vertical lines. The curves are the fitted missing mass spectra from the simulation. The comparison of histogram to curve shows how well the resolution effects are reproduced by the Monte-Carlo.

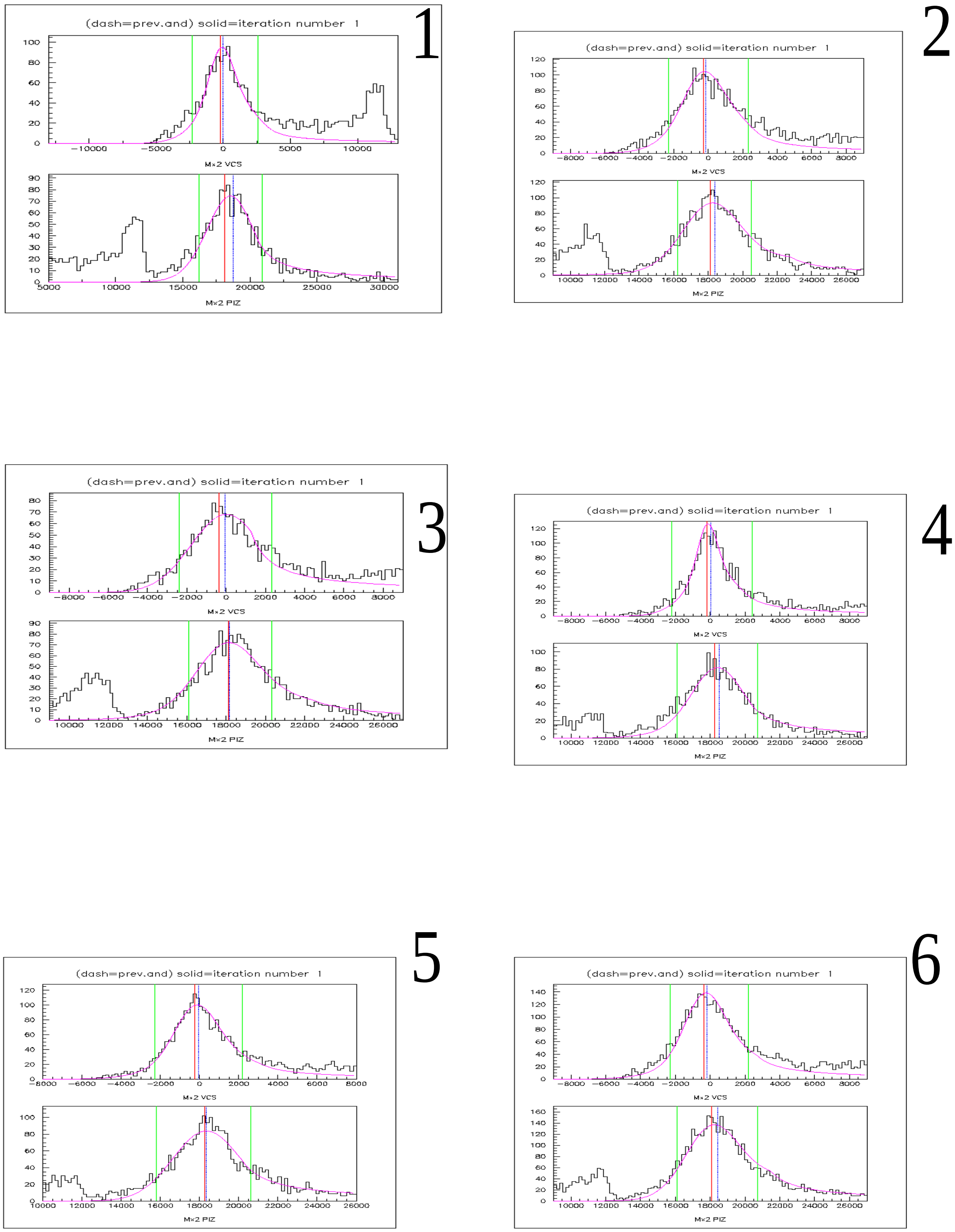


Figure 3: Adjustment of experimental missing mass (histogram) on simulation (curve) for DA1 settings 1 to 6.

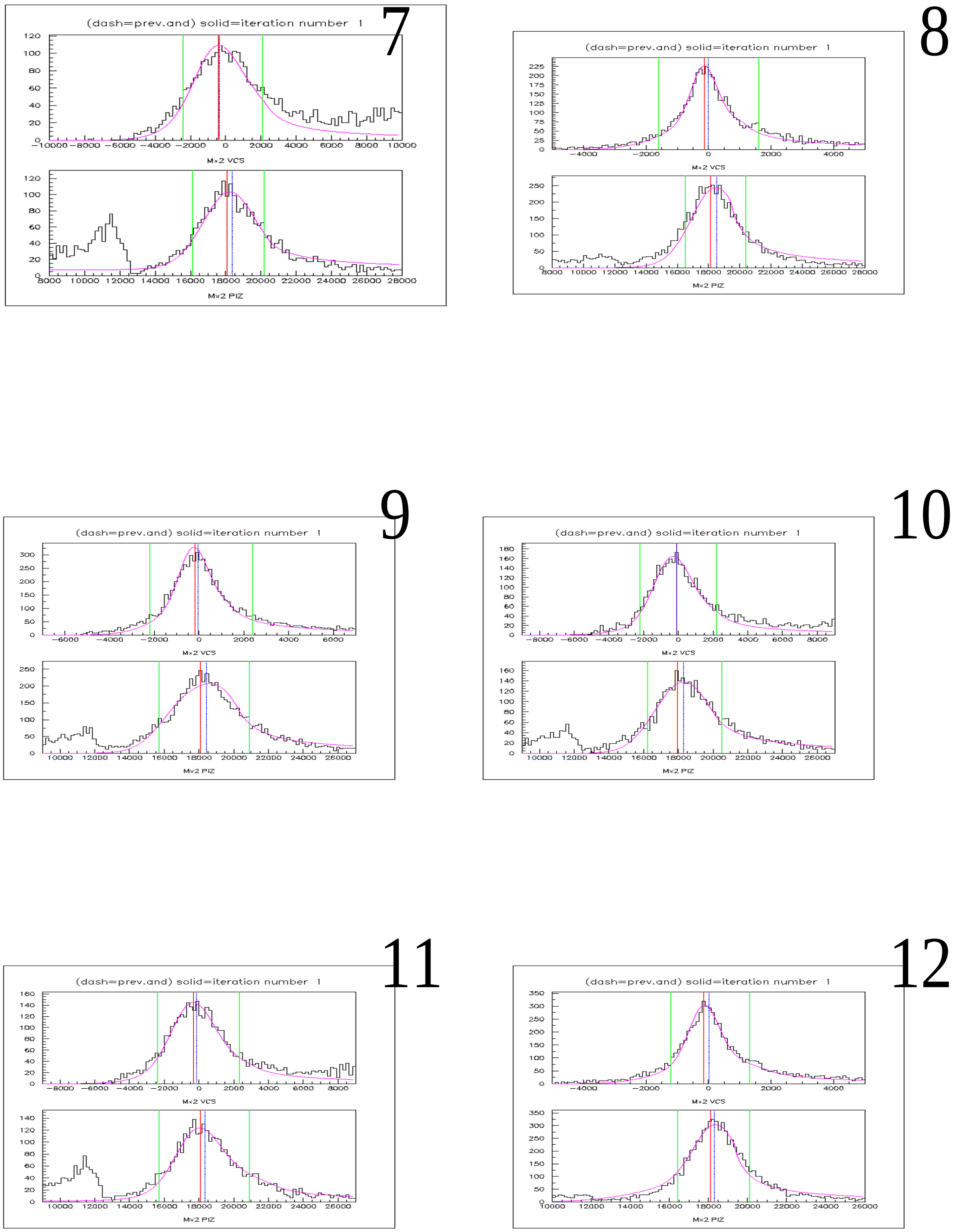


Figure 4: Adjustment of experimental missing mass (histogram) on simulation (curve) for DA1 settings 7 to 12.

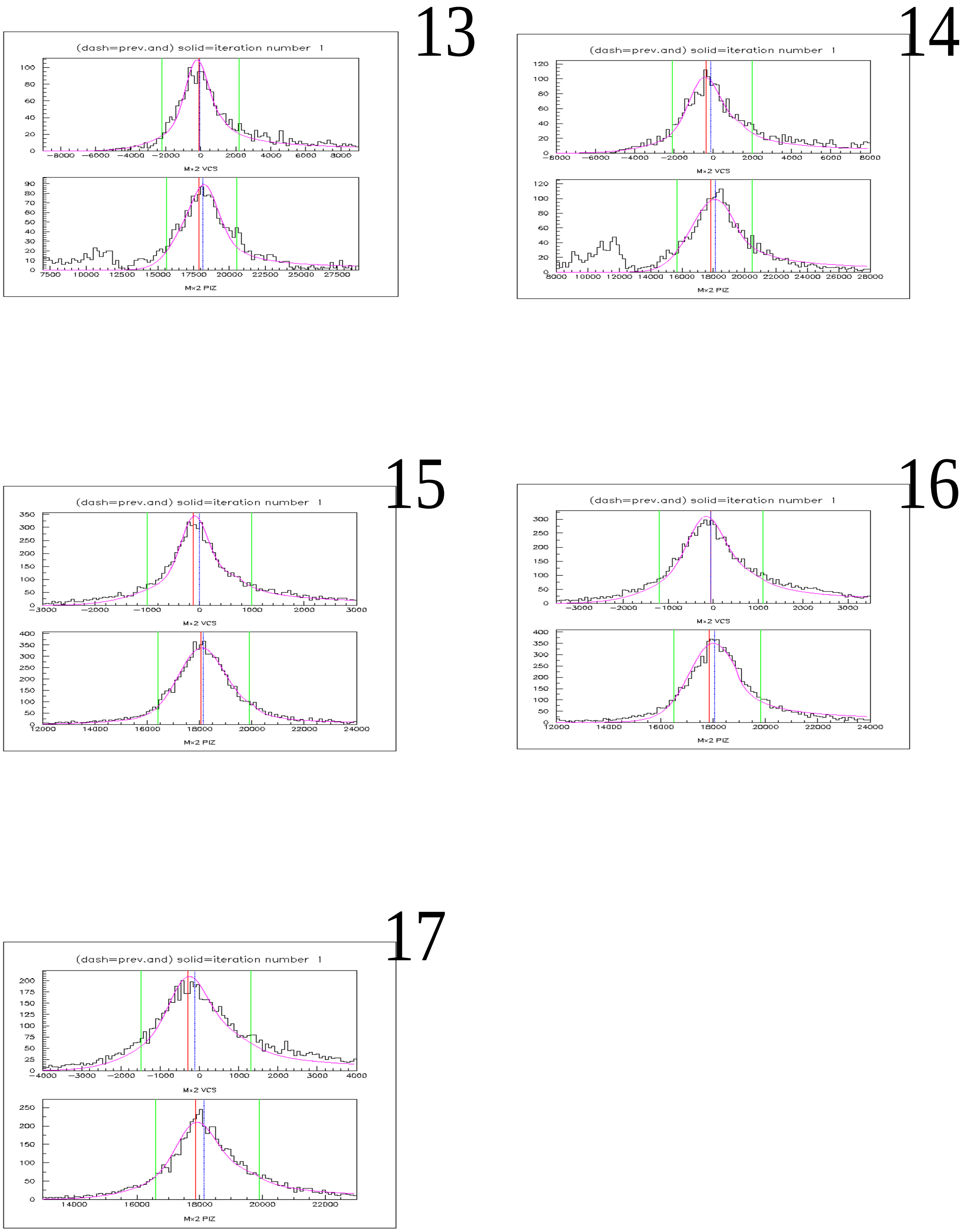


Figure 5: Adjustment of experimental missing mass (histogram) on simulation (curve) for DA1 settings 13 to 17.

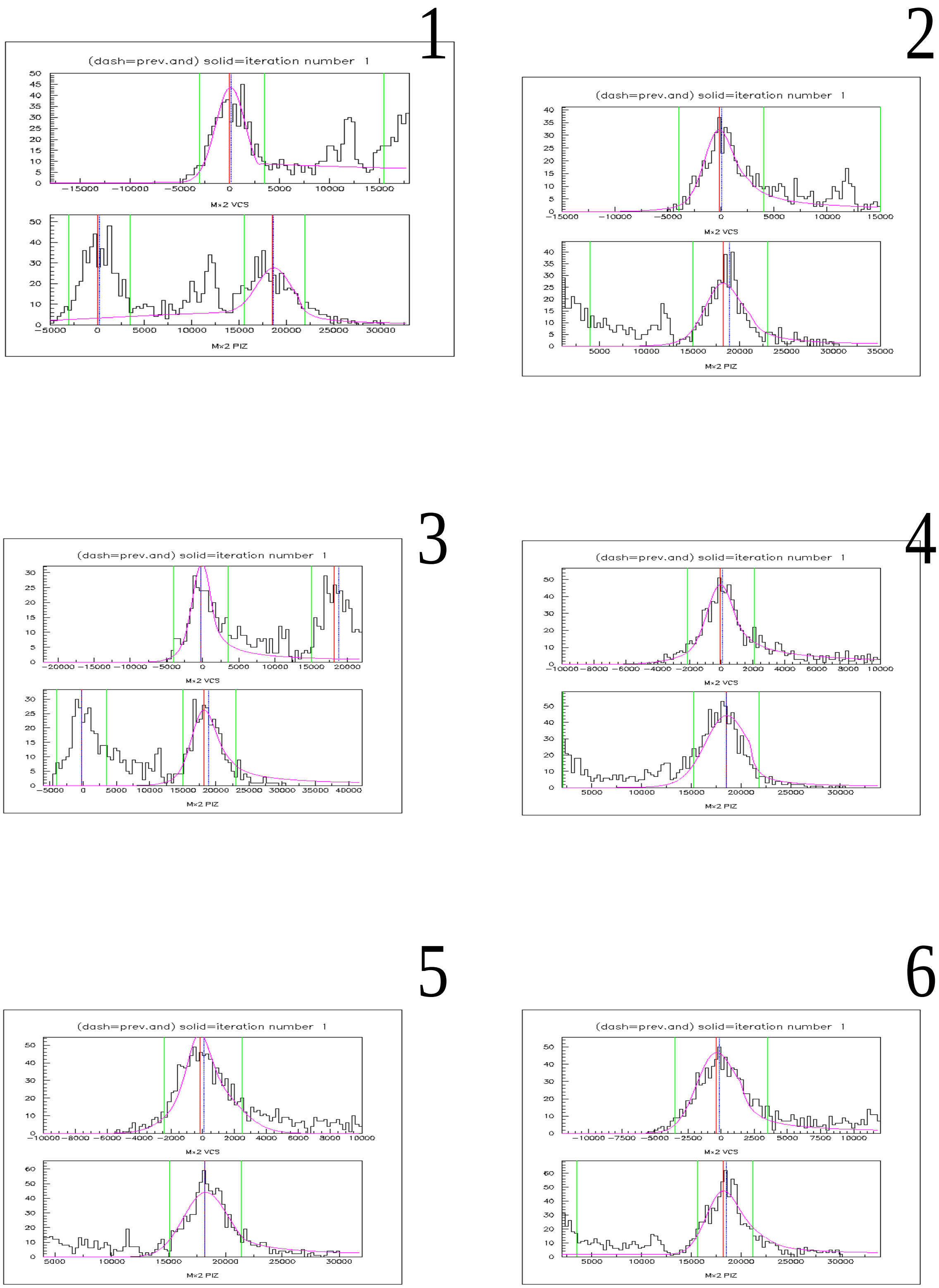


Figure 6: Adjustment of experimental missing mass (histogram) on simulation (curve) for DA2 settings 1 to 6.

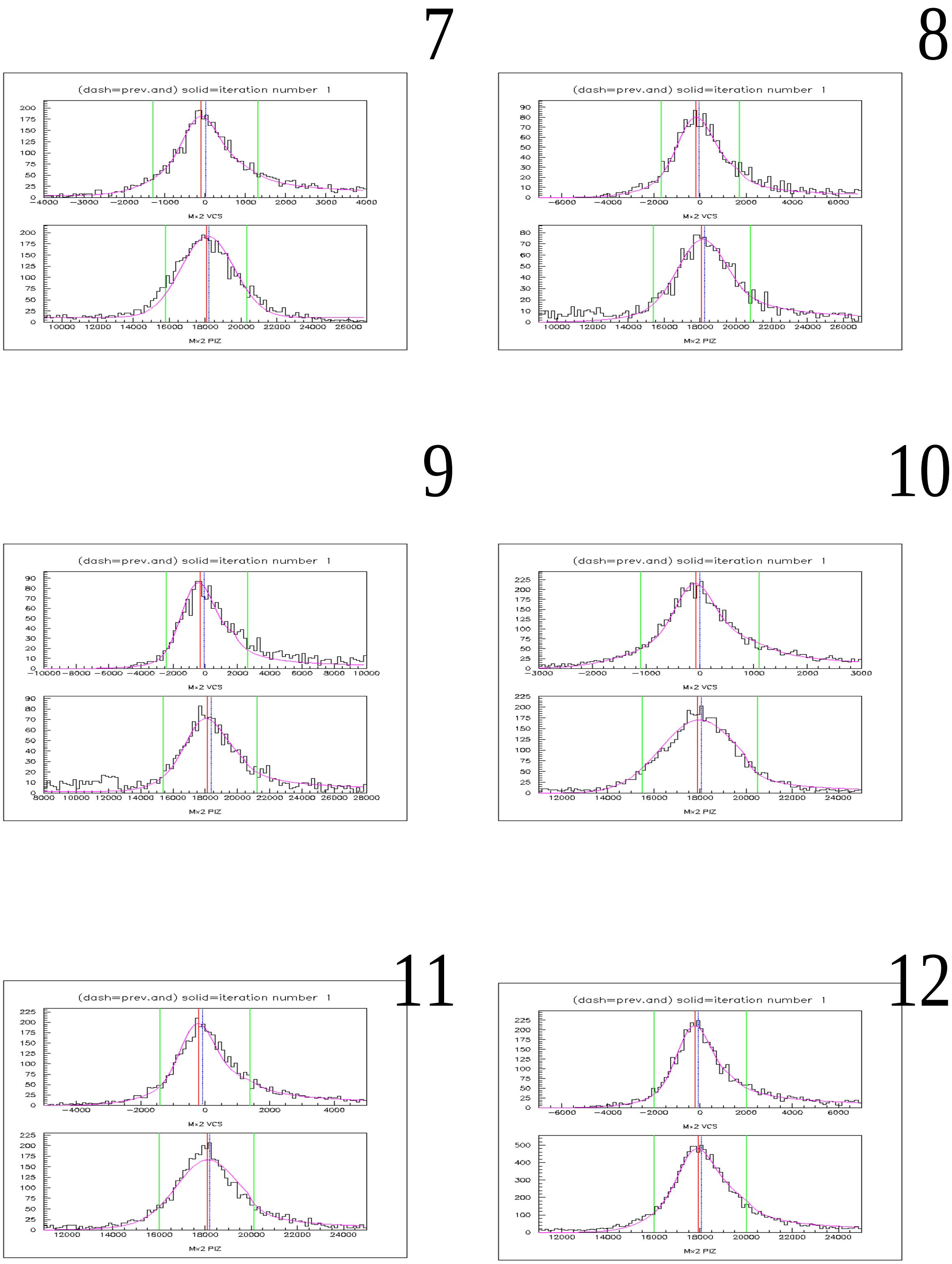


Figure 7: Adjustment of experimental missing mass (histogram) on simulation (curve) for DA2 settings 7 to 12.

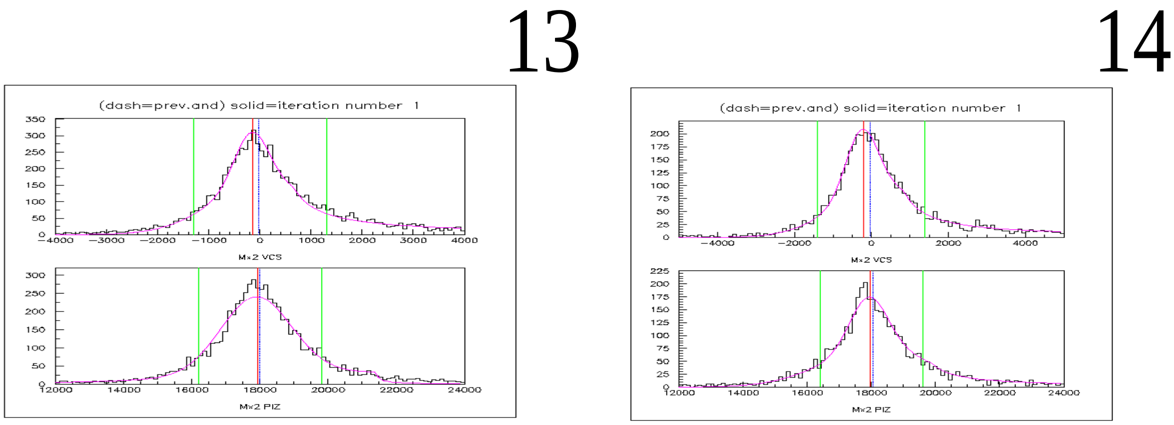


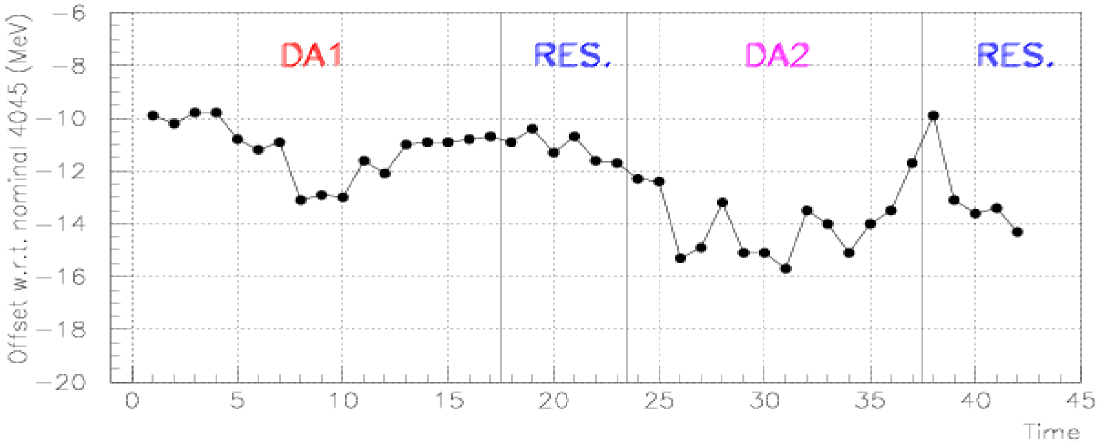
Figure 8: Adjustment of experimental missing mass (histogram) on simulation (curve) for DA2 settings 13 to 14.

7 Addendum 2

Below is a plot of the beam energy offset dEbeam as determined by the software method using missing mass optimization. The offsets have been determined for the whole range of settings used for DA1, DA2 (by H.Fonvieille) and resonance data (by Geraud Laveissiere).

2002/02/13 14.28

Beam Energy Offset in VCS-E93050 JLab Expt. NEW



time index 1 = setting da1−8
time index 2 = setting da1−9
time index 3 = setting da1−11
time index 4 = setting da1−10
time index 5 = setting da1−14
time index 6 = setting da1−13
time index 7 = setting da1−12
time index 8 = setting da1−15
time index 9 = setting da1−16
time index 10 = setting da1−17
time index 11 = setting da1−3
time index 12 = setting da1−2
time index 13 = setting da1−1
time index 14 = setting da1−4
time index 15 = setting da1−5
time index 16 = setting da1−6
time index 17 = setting da1−7
time index 18 = setting res1.30
time index 19 = setting res1.75
time index 20 = setting res1.50
time index 21 = setting res2.00
time index 22 = setting res2.25
time index 23 = setting res2.50
time index 24 = setting da2−1
time index 25 = setting da2−4
time index 26 = setting da2−5
time index 27 = setting da2−6
time index 28 = setting da2−2
time index 29 = setting da2−3
time index 30 = setting da2−14
time index 31 = setting da2−13
time index 32 = setting da2−10
time index 33 = setting da2−11
time index 34 = setting da2−12
time index 35 = setting da2−9
time index 36 = setting da2−8
time index 37 = setting da2−7
time index 38 = setting res1.50
time index 39 = setting res1.75
time index 40 = setting res2.80
time index 41 = setting res3.20
time index 42 = setting res3.60